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C. R. Zeisse, S. G. Gathman, D. R. Jensen, K. M. Littfin, W. K. Moison, B. D. Nener(1

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Space and Naval Warfare Systems Center
San Diego, CA 92152–5001

University of Western Australia(1)
Nedlands, Australia, 6907

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The propagation of infrared radiation close to the ocean surface is controlled by three effects: (1) extinction (absorption and scattering) by aerosol particles, (2) extinction by molecules, and (3) refraction. Molecular extinction can be predicted with fair accuracy by transmission codes such as MODTRAN, and refraction can often be ignored along paths shorter than 10 km. Hence, by making continuous measurements of infrared transmission, a continuous record of aerosol transmission after removing the molecular transmission should be obtainable. This paper shows that this is indeed the case for mid- and longwave infrared transmission measured several meters above San Diego Bay.

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MARINE AEROSOL PARTICLES AND INFRARED TRANSMISSION

C. R. Zeisse[1], S. G. Gathman[1], D. R. Jensen[1], K. M. Littfin[1] W. K. Moision[1], and B. D. Nener[2]

[1]Space and Naval Warfare Systems Center, San Diego CA 92152-7385 USA
[2]University of Western Australia, Nedlands, Western Australia, Australia 6907

KEYWORDS

Aerosol, Transmission, Marine, Infrared

The propagation of infrared radiation close to the ocean surface is controlled by three effects: (1) extinction (absorption and scattering) by aerosol particles, (2) extinction by molecules, and (3) refraction. Molecular extinction can be predicted with fair accuracy by transmission codes such as MODTRAN, and refraction can often be ignored along paths shorter than 10 km. Hence, by making continuous measurements of infrared transmission we should be able to obtain a continuous record of aerosol transmission after removing the molecular transmission. We show that this is indeed the case for mid- and longwave infrared transmission measured several meters above San Diego Bay.

Transmission in the midwave band (3.6 to 4.1 μm) and the longwave band (9.8 to 11.4 μm) was measured continuously from November 6 to 19, 1996. The transmitter, containing a 1200 K blackbody, was located 6.2 m above mean sea level at the Naval Amphibious Base, Coronado and receivers, containing discrete 1 mm infrared detectors, were located 4.9 m above mean sea level at

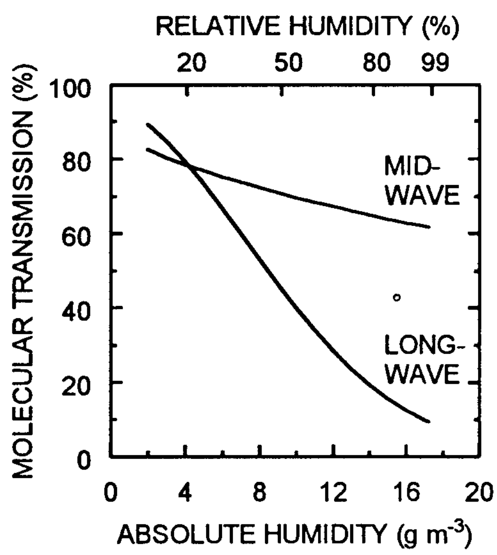

Figure 1. Broad band molecular transmission predicted by MODTRAN 3.5 as a function of absolute humidity in clear air at 20 C. The range is 7 km. The spectral bands for this calculation were chosen to match those used by our receivers.

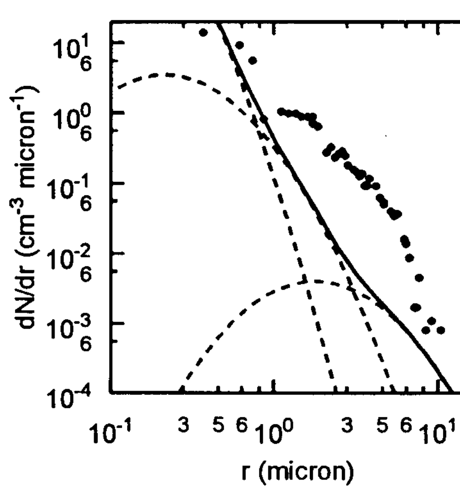

Figure 2. Size distribution of aerosol particles. Solid circles: measured in San Diego Bay. Solid line: predicted by the Navy Aerosol Model. Dashed lines: components of the Navy Aerosol model.

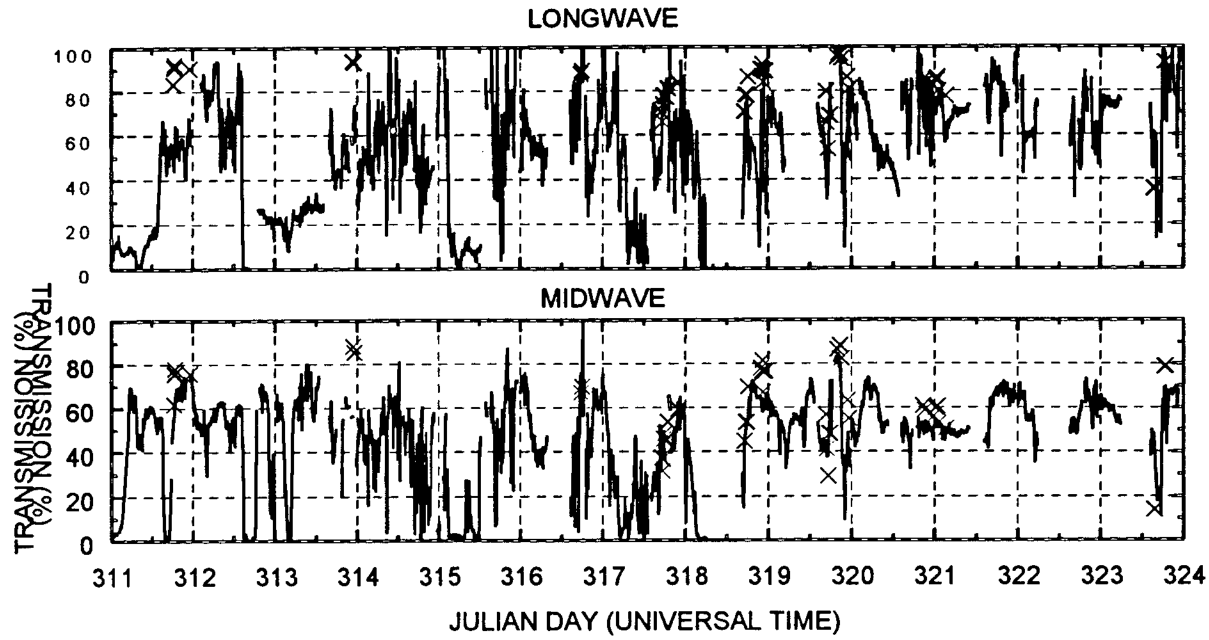

Figure 3. Longwave (upper) and midwave (lower) infrared aerosol transmission for a thirteen-day period in November 1996. The solid line is the measured transmission after molecular effects are removed. The crosses are the transmission predicted by Mie theory and Beer's Law from particle size distributions measured along the 7.0 km optical path.

the Naval Submarine Base, San Diego. The 7.0 km optical path between them ran across San Diego Bay. The absolute accuracy of the transmission measurement was ± 30%. A mid-path buoy collected continuous meteorological data, and aerosol particle sizes were occasionally measured by carrying a classical scattering aerosol spectrometer along the path in a small boat. All data were averaged for a ten-minute period.

Figure 1 shows the clear air molecular transmission predicted by MODTRAN for a 7 km path through a 1976 Standard Atmosphere. For ranges of humidity encountered throughout a typical day, we see that molecular transmission is higher and much more constant in the midwave band than it is in the longwave band. Figure 2 shows one of the particle size distributions measured along the path and compares it with the predictions of the Navy Aerosol Model for the meteorological conditions prevailing at that time. The model, which is for the open ocean, under-predicts the distribution, which was measured near the coast. That is just what we would expect. The solid lines in figure 3 show the measured transmission data after division by the molecular transmission predicted from the absolute humidity measured at the buoy. These lines compare well with the crosses, which show the aerosol transmission obtained from the measured particle size distributions using Mie theory and Beer's law.

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